

Enhanced Agent based User Mobility Support Mechanism in RFID Networking Environment

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Abstract— We propose enhanced agent based user mobility support mechanism in RFID networking environment. Although there is an existing study for providing user mobility, it has a problem which the handover latency time is long. To solve this problem, we present a scheme for minimizing handover latency time and compare handover latency time of existing and proposed scheme. We confirm that proposed mechanism has low handover latency time than existing mechanism by mathematical analysis using the queuing theory and show that proposed mechanism is more superior to the existing mechanism.

Keywords— user mobility, seamless service, handover, RFID, latency time

I. INTRODUCTION

Many schemes have been investigated in the ubiquitous network environment, where multimedia services such as streaming services and user recognition-based services are supported using hardwares, sensors and radio waves[1]-[3]

The ubiquitous network environment should support seamless mobility for multimedia services.

In figure 1, the portability is supported in the ubiquitous network for the multimedia service. figure 1 shows that a user who enjoys multimedia service using mobile terminal like PDA in the outer wireless network moves into the home network, and then the service needs to be continuous on another terminal in the home network. That is, when the mobile terminal is connected to a personal computer or IPTV, the streaming service on the mobile terminal should be transferred to the fixed terminal in the home network, which achieves seamless multimedia service.

When the user moves to another terminal within the same home network, the terminal should be able to recognize the user identification, to get the information of the service having been served for the user from the HG(Home Gateway), and to provide seamless service continuously using the information[4].

Figure 1 presents terminal mobility from wireless network to home network and user mobility within home network. RFID is used to support user mobility. RFID can be used to one of the solutions recognizing a user for seamless service.

Existing scheme of the Figure 1 supports local mobility in home network environment while we want to extend the scope to support mobility in RFID networking environment. Generally, to support mobility, session maintenance is indispensable.

A session has to be maintained in order to provide mobility. In IP based network, a session refers to the IP address and port number. In case of using RFID for the recognition of user, the RFID reader reads the RFID tag ID and recognizes a user.

However, the RFID tag ID cannot be used like the IP address or port number in the IP network as the information for the session maintenance. In IP network, a method for providing the seamless service through the session maintenance to the user with the RFID tag is required.

In this paper, we propose enhanced agent based user mobility support mechanism in RFID networking environment. To solve a problem which an existing scheme has long handover latency time, we present a scheme for minimizing handover latency time and compare handover latency time of existing and proposed scheme.

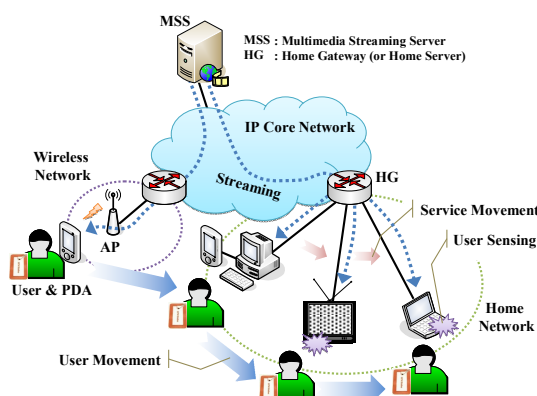


Figure 1. The service mobility concept by user movement

This paper is organized as follows. We describe about the related work in Section II. The proposed scheme is explained in Section III. In Section IV, we evaluate performance of existing and proposed scheme. Finally, conclusion is given in Section V.

II. RELATED WORK

A. The study of the User Mobility in Home Network

Figure 2 shows the architecture of the home network. The Home Server (HS) stores user profile information which is related to user locations, the services being used by users, and so on. The UT executes registration of user's current location and service profile, such as MS(Multimedia Server)'s IP address and service name, in the HS in the case of user's initial registration, and executes registration of user's current location in the HS and requests the service profile related to the service having been used at the previous UT to the HS in the case of user's handover.

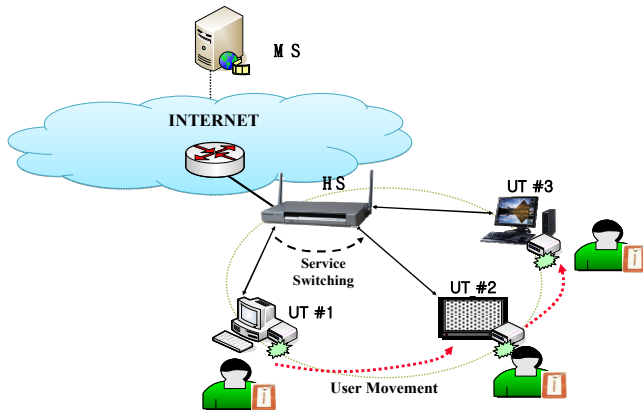


Figure 2. Architecture of home network

RFID readers and Tags are used to make the UTs recognize the access of users. The MS is a multimedia server which is located out of the home network.

Figure 3 shows the procedures in order to register user's current location as well as service profile in the HS and acquire user's service profile from the HS.

First, in the case of user's service initiation, a user accesses the UT#1, which gets the User ID using RFID and requests User Registration to the HS. The HS confirms that there is not the same User ID as the received User ID in its data table, and registers the User ID in the data table. After then, it sends User Registration Ack to UT#1.

In addition, the UT#1 also sends Service Registration Request Message including MS's IP address and service name decided by the user. The HS records the MS's IP address and the service name in the same record of its data table as the corresponding User ID, and sends Service Registration Ack to UT#1.

Second, in the case of user's handover, the user accesses the UT#2 from UT# 1. The UT#2 recognizes the User ID using RFID, and sends User Registration Request to the HS. The HS confirms that its data table includes the same User ID as the received User ID, and sends User Service Info Ack with the MS's IP address and service name recorded in the data table in the process of user's service initiation, which is the cache function of the HS. Finally, the HS ceases the session with the UT#1[5].

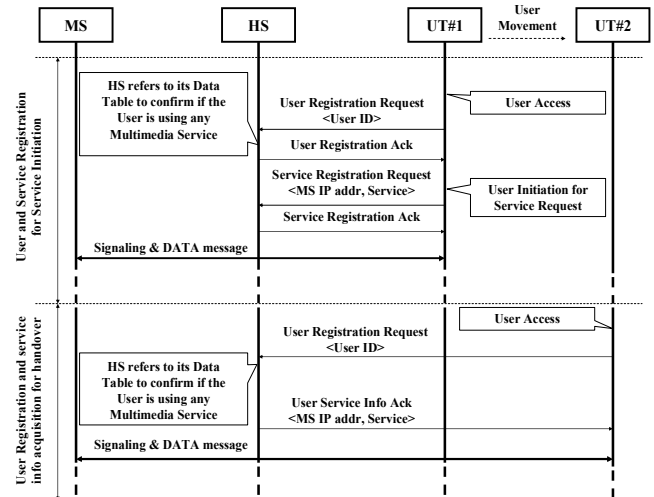


Figure 3. Procedure of user registration and service information acquisition for handover

B. The study of Networking using RFID

1) Network Configuration

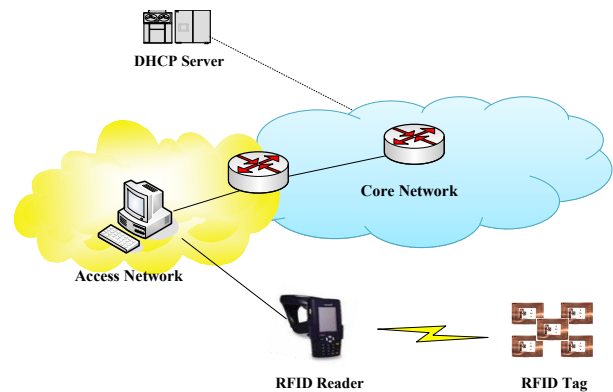


Figure 4. Network Configuration

The network configuration of figure 4 is comprised of the core network and access network. In the core network, a router and DHCP Server are located and in the access network, RFID Reader is connected.

The role of each compositional element is reviewed below. In core network, a router delivers the packet as confirming IP

address of the destination. The DHCP server dynamically assigns the IP address.

The RFID Reader performs the role that it reads the RFID tag ID or records data in the RFID tag. Moreover, the address management agent is positioned inside the RFID Reader. The address management Agent is delivered the RFID tag ID and creates the virtual physical address of forty-eight bits. And the RFID tag ID, the produced virtual physical address, and the IP address assigned at the DHCP server are mapped and it stores in the storage device.

2) Operation Procedures

The figure 5 is the process flow diagram showing the procedure of producing the IP address about the RFID tag ID.

In figure 5, the RFID tag ID is delivered to a RFID reader. A delivered RFID tag ID is read by the RFID reader. The RFID reader delivers the read tag ID to the agent. The agent stores the tag ID in storage device.

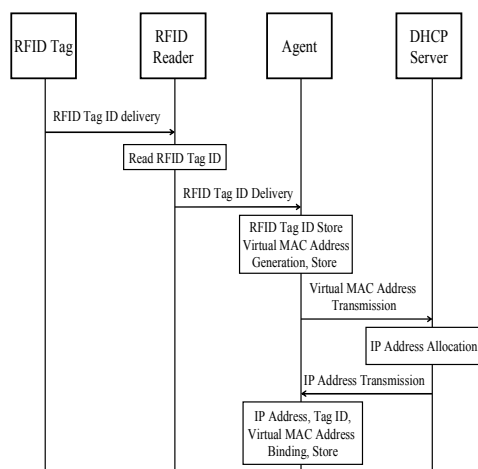


Figure 5. The flow of IP address generation process

Moreover, the agent generates a virtual physical address by using the RFID tag ID. The agent maps these information and stores in storage device.

An agent transmits the generated virtual physical address to the DHCP Server. The DHCP server receives the virtual address and assigns the IP address. And the DHCP server transmits the assigned IP address to an agent. An agent binds the received IP address, the RFID tag ID, and the virtual physical address and stores in the storage device[6].

C. The study of the User Mobility in RFID Networking Environment

Figure 6 is the network configuration for providing user mobility. A network is classified into the IP core network and the access network. And the compositional elements are as follows.

There are the IP core network which the DHCP server is connected and the access network which includes an agent#1 and an agent#2 which are connected to the RFID reader. A user has the RFID tag. The RFID reader delivers the RFID tag ID to the agent which produces the MAC address using the RFID tag ID. By using the produced MAC address, an agent is assigned the IP address from the DHCP Server. And the RFID tag ID and IP address are mapped and stored in the storage device. In the agent, there is the MIP (Mobile IP) function. And it operates with HA(Home Agent) or FA(Foreign Agent). The detail procedure of the proposed user mobility mechanism is as shown in figure 7. It is based on the following assumption before illustrating the detail procedure.

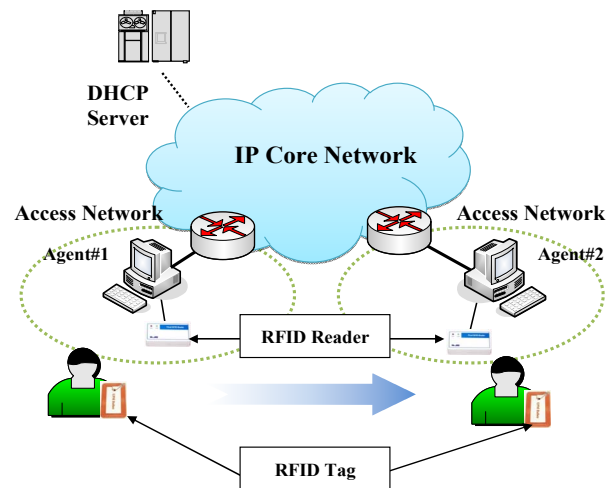


Figure 6. Network Architecture

In the proposed network configuration, an agent#1 is the HA and an agent#2 plays the role of the FA about the tag of a user. When each agent produces the MAC Address by using the RFID tag ID of a user, it produces the MAC address which is unchangeable at all times about the unique RFID tag ID. Moreover, the generated MAC address is unique. And in the IP core network, the Mobile IP is applied.

The detail procedure can be divided to the mainly two parts. One is the case that the user having the RFID tag is positioned at an agent#1 (figure 7-(1)). The other one is the case that the user having the RFID tag moves from an agent#1 to an agent#2 (figure 7-(2)).

First, when a user comes into an agent#1, the RFID Reader connected to an agent#1 recognizes the RFID tag ID and delivers it to an agent#1. An agent#1 produces the MAC address and transmits it to the DHCP server. The DHCP server assigns the IP address to the received MAC address. The DHCP server stores the MAC address and the assigned IP address. The allocated IP address is transmitted to an agent#1. An agent#1 stores the RFID tag ID and IP address of a user in the storage device.

Second, when a user moves from an agent#1 to an agent#2, an agent#2 is delivered the RFID tag ID and produces the

MAC address like the an agent#1. And the MAC address is transmitted to the DHCP server. The DHCP server searches the IP address correspondent to the received MAC address. If there is the existing IP address, the DHCP server transmits the existing IP address to an agent#2. An agent#2 stores the RFID tag ID and IP address of a user in the storage device. And an agent#2 updates the binding information to an agent#1. Then, a tunneling is made between an agent#1 and an agent#2. Thereafter, the procedure for the mobile IP is accomplished[7].

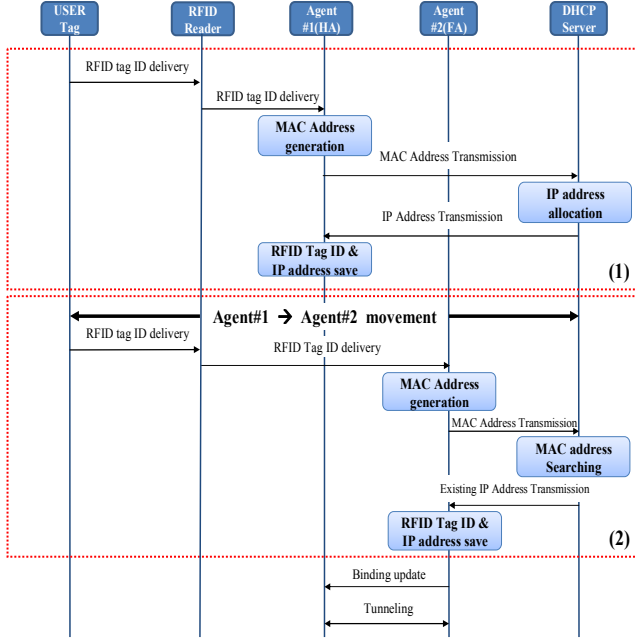


Figure 7. The procedure of mobility mechanism

III. PROPOSED MOBILITY MECHANISM

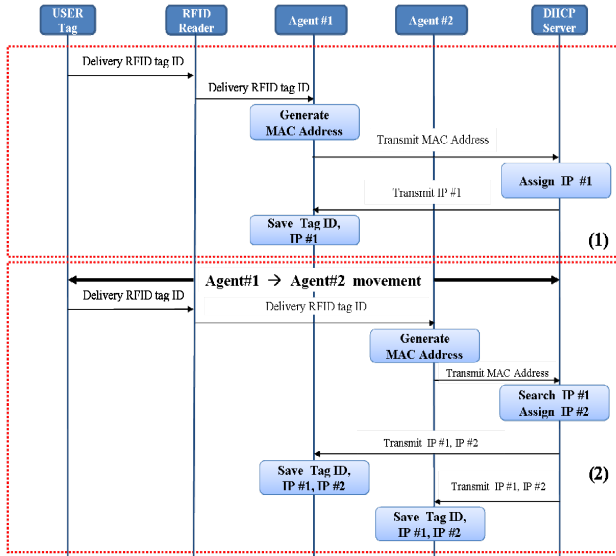


Figure 8. The procedure of proposed mechanism

Network configuration applied proposed mechanism for supporting user mobility is identical with figure 6. The detail procedure of the proposed user mobility mechanism is as shown in figure 8.

When each agent produces the MAC Address by using the RFID tag ID of a user, it produces the MAC address which is unchangeable at all times about the unique RFID tag ID. Moreover, the generated MAC address is unique.

In figure 8-(1), the procedures are identical with existing scheme. However, when existing scheme is compared with proposed scheme, figure 8-(2) described handover procedure is different.

When a user moves from an agent#1 to an agent#2, an agent#2 is delivered the RFID tag ID and produces the MAC address like the an agent#1. And the MAC address is transmitted to the DHCP server. The DHCP server searches the IP address (IP #1) correspondent to the received MAC address and also assigns a new IP address (IP #2). The DHCP server stores mapped MAC address, IP #1 and IP #2. Finally, it transmits IP #1 and IP #2 to an agent#1 and an agent#2 respectively.

Agent#1 and agent#2 store the RFID tag ID, IP #1 and IP #2 of a user in the storage device.

IV. PERFORMANCE ANALYSIS

In this section, we compares latency time of user mobility mechanism #2 described in section II with proposed scheme.

We only consider the processing time of network element in terms of handover delay because we assume the transmission time is same. For performance analysis, we use M/M/1 queuing model, and the total processing time of each network element depends on the number of layers.

According to [8], [9], let M_x be the set of messages processed in a network element x , and the utilization of a network element x , ρ_x , is obtained by

$$\rho_x = \sum_{l \in M_x} (\lambda_l / u_l) \quad (1)$$

Where λ_l and u_l are the mean arrival rate and the mean service rate of messages of type l . We assume that the mean arrival rate of message l is equal for all messages in a network element. This assumption implies

$$\lambda_l = \lambda_x \text{ for all } l \in M_x \quad (2)$$

Where λ_x is the mean arrival rate of any message in network element x . From (1) and (2), the mean sojourn time of message l in a network element x , σ_l is obtained by

$$\sigma_l = 1 / \{u_l(1 - \rho_x)\} \text{ with } l \in M_x \quad (3)$$

We define the total service time in a network element x , s_x

$$s_x = \sum_{l \in M_x} (1/u_l) \quad (4)$$

That is, s_x is the time that is spent to process all messages arriving in the network element x . The total service time, S is then expressed as

$$S = \sum_{x \in E} s_x \quad (5)$$

Where E is the set of network elements. Therefore, the total service time for each scheme is presented in Table 1.

Table 1. Expression for total service time

Scheme	Expression
Existing	$2S_{L2} + 4S_{L3+DB} + S_{L3} \times \alpha + 2(n-1)S_{L3}$
Proposed	$2S_{L2} + 3S_{L3+DB} + S_{DB} + 2(n-1)S_{L3}$

Where α is the number of immediate node(L3) between agent#1 and agent#2.

Table 2. Service time in network element

Total service time	Time
S_{L2}	2.59ms
S_{L3}	10ms
S_{L3+DB}	17.4ms

Table 3. Expression for total processing time

Scheme	Expression
Existing	$\{2s_{L2} + 4s_{L3+DB} + \alpha s_{L3} + 2(n-1)s_{L3}\} / (1-\lambda)$
Proposed	$\{2s_{L2} + 3s_{L3+DB} + s_{DB} + 2(n-1)s_{L3}\} / (1-\lambda)$

s_{L2} is packet service time of MAC layer. s_{L3} is packet service time in MAC and network layers. s_{L3+DB} is packet service time by operating database plus s_{L3} service time.

We assume that the processing time of each layer's header in an element is in proportion to that of IP header, and that

the database (DB) processing delay in Table 2 is same as the processing time of IPv6 header. We derive the processing delay in each layer from the processing time of each layer's header[8], and the service time in each network element according to element type can be calculated as Table 2.

Given that the reference arrival rate of a message at a network element is λ , we define the effective call arrival rate, λ_x^{eff} , of a message.

$$\lambda_x^{eff} = \lambda / s_x \quad (6)$$

From (3) and (6), the total processing time of each scheme is presented in Table, where n is the hop number between access and core network elements.

Figure 9 and Figure 10 show a handover latency time against the handover rate of packets using Table 3.

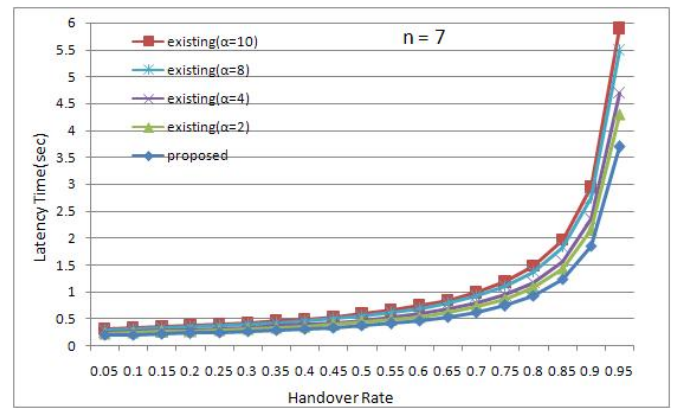


Figure 9. Handover latency time VS handover rate

Figure 9 is a graph which is calculated by fixing a value ($n=7$) of n and by changing a value ($\alpha=2, 4, 8, 10$) of α in existing scheme.

When a user moves from HA(agent #1) to FA(agent #2), an existing scheme needs the binding update procedure because of using Mobile IP. We reflect a value of α which presents the number of passing immediate node in binding update procedure.

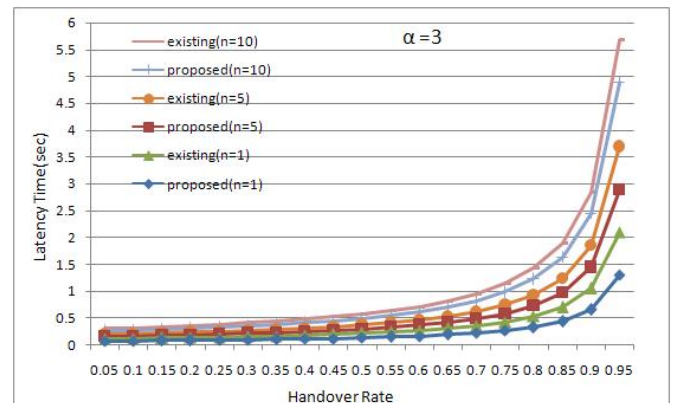


Figure 10. Handover latency time VS handover rate

Figure 10 is a graph which is calculated by fixing a value ($\alpha=3$) of α and by changing a value ($n=1, 5, 10$) of n .

A value of n shows the number of hop between core network element and access network element. The number of hop is changed to 1, 5 and 10.

In figure 9 and 10, we compare proposed scheme with existing scheme. In respective figure, proposed scheme has low handover latency time than the existing scheme.

The reason handover latency time of existing scheme is longer than proposed scheme is due to binding update of Mobile IP.

When agent#2 transmits binding update message to agent#1 in existing scheme, immediate nodes exist between agents.

Whereas, proposed scheme doesn't need binding update procedure of existing scheme because IP #1 and IP #2 transmit to agent #1 and agent #2 directly. Hence, handover latency time is decreased.

V. CONCLUSIONS

We propose enhanced agent based user mobility support mechanism in RFID networking environment. Although there is an existing study for providing user mobility, it has a problem which the handover latency time is long. To settle this problem, we present a scheme for minimizing handover latency time and compare handover latency time of existing and proposed scheme. We confirm that proposed mechanism has low latency time than existing mechanism by mathematical analysis using the queuing theory and show that proposed mechanism is more superior to the existing mechanism.

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